Eyles

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Apollo Project Memo # 7-69

TO: Distribution
FROM: George W. Cherry
DATE: January 23, 1969
SUBJECT: What is LUMINARY 1A?
Some Results of the 28th Apollo Software Configuration Control Board Meeting

The release date for LUMINARY 1A, the Mission "G" program is scheduled for 19 March 1969 as the result of SCB approval of PCR's on the baseline program which was scheduled for release on 15 March 1969. This memo describes, by technological area, the presently approved contents of LUMINARY 1A. It also alludes to LUMINARY 1A items which were disapproved. We must now prepare a detailed development plan and test plan for LUMINARY 1A.

In this memo I have given action items for the implementation of the changes. My assignments must be confirmed by Dan Lickly or Jim Kernan. In some cases I have also given additional information about implementing the PCR which cannot be found in the PCR itself. For some PCR's we will have to hold a design review.

I would like to have the development plan handle the initial programming changes by PCR status; - PCR Design Review complete date, PCR item test plan complete, PCR GSOP change pages complete, PCR coding complete, PCR testing complete, etc. By doing this we should prevent the changes and improvements from introducing new problems.

The items which changed the delivery date of LUMINARY 1A are:

PCR 270 Placement of Desired Insertion Radial Velocity component into Erasable for P70/P71/P12 - One Day.

PCR 722 Improve Performance of RR Designate Routine on the Lunar Surface - Two Days.

PCR 268.2 Reduction of P34/P35 Run Time - One Day for detailed change evaluation.

Abort and Ascent Changes (Approved)

1. Reduce program execution time in P70, P71, and P12.
   Action: Craig Schulenberg and Larry Berman.

2. PCR 697. Limit LM Abort Orbit Insertion to One-half Degree Plane Change.
   Action: Larry Berman.

3. PCR 708. Provide Continually Variable Abort Insertion Targetting.
   Action: Larry Berman, John Vella and Craig Schulenberg.

   There will be two polynomials of the form

$$V_{hf} = a + b(TFI) + c(TFI)^2 + d(TFI)^3$$

   one for DPS abort and one for APS abort (a, b, c and d in erasable). After V_{hf} is determined N76 registers should be loaded so that the crew can see what V_{hf} is. N76 is redefined by this PCR and PCR 270.

N76	R1	VHF
	R2	HDOT F
	R3	CROSS RANGE

   A design review will be required to determine whether N76 should normally come up in P70/71 or merely be an on-call display. Also, should we let this noun be loadable in P70/P71? Probably not.

4. PCR 717. DAP Bias Acceleration Initialization in P12.
Action: Bill Widnall and Craig Schulenberg.
Question: Should we do this in P71 also?

5. PCR 260. We already had a design review on this subject and we are doing it the way Craig Schulenberg proposed.
GSOP Action: Walker Kupfer and Bill Marscher.
Action: Craig Schulenberg.

6. PCR 270. Allow Non-Zero Radial Rate Insertion Targets in P70, P71 and P12.

The purpose of this change is to get to the apolune of the abort orbit and hence the CSI burn about 14 degrees of central angle travel sooner. Since CDH is done one half rev after CSI this will add about 4.5 minutes between CDH and TPI. Also, positive flight path angles will put apolune before perilune - which seems safer to me.

The details of the change are:

a. One pad load of HDOT F for P70/P71 and
b. A different pad load of HDOT F for P12. (If we haven't this unshared erasable for P12 we can use fixed storage since the crew can load N76 in P12 if the value loaded from fixed is wrong.)
c. Change N76 definition as noted above.

One question then, should we make N76 loadable in P70/P71 as well as P12?

DAP Changes (Approved)

Action: Bill Widnall

1. PCR 715 Increase Docked DAP Bending Stability.
2. PCR 716 Improve Ascent Powered Flight RCS Control.
3. PCR 717 DAP Bias Acceleration Initialization in P12.

DAP Changes (Approved) (Cont.)

4. PCR 718 Improve Light Ascent Control with Jet Failures.

5. PCR 701 Eliminate Trim Gimbal Control Underflow From CSM-Docked LM DAP.

6. PCR 710 Provide a Larger RCS Pulse Width During Minimum Impulse Control Modes with CSM Attached.

Bill, what pulse width do you propose?

Navigation Changes (Approved)

1. PCR 267 Synchronize the RR Data for the Downlink.

Action: Jim Kernan

2. PCR 646 Give astronaut the option to confirm main-lobe lock-on after R21 acquisition.

Action: Programming - Peter Volante

GSOP - Walker Kupfer
Harry McQuat

3. PCR 722 Improve performance of RR designate routine on the Lunar surface.

Action: Programming - Peter Volante

GSOP - Bob White (5)
Harry McQuat (4)

4. PCR 642 Provide wings-level, head-up, fine Z-axis tracking. Not heads up, but merely memory, so to speak, of what the astronaut specified. Don Keene knows how to do this. Modify VECPOINT so that there is an entry point which uses CDUXD, CDUYD, CDUZD rather than the actual CDUs. Thus R65 will call VECPOINT at this new entry point and the limit cycling of the DAP etc. will not be rectified.

Action: Bill Widnall, Don Keene and Pete Volante

5. Landing Changes (Approved)

1. Eliminate Attitude Oscillations from Terminus of P64

No PCR has been written yet - but Bill Widnall and Allan Klumpp have simultaneously hit on a solution I think, and a PCR (or PCN) should be forthcoming from them. The problem, apparently, is that the guidance equations are computing commands on the basis of a state vector which is about a second old and then the DAP lags and throttle response are implementing the commands on the order of a couple of seconds late. (The DAP deadband, apparently, is okay at one degree.) These lags cause oscillations. It is easy to adjust for this problem by extrapolating the guidance equations commands forward from the time, PIPTIME, at which the state was computed. The lead in the equations compensates for the computation lags and the DAP and throttle lags. Allen has tried 3 seconds forward extrapolation and this really smoothes out the attitude profile.

Action: Allen Klumpp and Bill Widnall to verify their hypothesis and submit a PCR to me.

2. PCR 700 Improve the ROD Mode (P66) Performance.

I had several conferences on the P66 problem while I was at MSC and we are going to do at least the following things outlined below. The G crew, Warren North, Don Cheatham, Ken Cox and many others agreed with the following changes. By the way, our contact with MSC on this and the above problem was offically defined for me by C. Kraft. Our contact is the Guidance and Control Division (Don Cheatham) and Thomas Price. Here are the changes we should implement. (In our conference, having P66 define an HDOTD other then HDOT, on initial entry, was completely shot down.)

a. Put the scale factor for x ft/second per click into erasable.
b. Perform the rate of descent equations and commands once per second.

c. Update the DSKY HDOT display once per second. That is, let the ROD computations update HDOT. (H too, maybe?) This is important because the LM pilot calls out to the LM commander the DSKY display of HDOT during the final descent.

d. Prevent the loss of clicks between the rotation of the Mode Control switch to ATT HOLD and the beginning of P66. This should probably be implemented by having the Landing Auto Modes Monitor Routine, R13, zero the ROD counters and start the recognition of the incoming clicks. They do not want to be able to enter clicks early, for example, in P64.

Programming Action: Dan Lickly
Craig Schulenberg

GSOP Action: Walker Kupfer
Harry McQuat

3. PCR 670 Simplify Landing Programs

Program Action: Don Eyles

GSOP Action: Allen Klumpp (5)
Walker Kupfer (4)

Landing Items (Disapproved)

PCR 704 LR Antenna Rotation

PCR 705 LR Lateral Velocity on Downlink

PCR 706 Use of LR Antenna Position Discrete

PCR 649 DPS Propulsion Constants (Landing)

We were given the direction to use the latest numbers in the data book. All the calculated numbers should be consistent with the numbers in the data book.

Action Item: Allan Klumpp, please make up the GSOP change page reflecting compliance with the direction.

Craig Schulenberg - Please see that the correct numbers get into the program.

PCR 257 LR Diagnostic Downlink

PCR 723 Two Segment LR Altitude and Velocity Weighting Functions

I'm not very persuasive because I couldn't persuade the board to approve PCR 723. Kraft was loath to approve it because the discussion about it showed some differences of opinion, I believe. I believe we will want to submit this again when we have everyone with us.

Alignments (Approved)

PCR 696 Add V06N22 Display in P57.

PCR 698 Add LM Position Determination Capability to P57.

PCR 699 Permit Pad Load of AOT Back Detent AZ and EL Angles.

PCR 702 Add COAS Calibration Option to R52.

Design reviews for all these items have been held.

Programming action on all the above: Don Millard

GSOP Action: Bob White (5)
W. Kupfer/H. McQuat (4)

AOH Addition to describe COAS Calibration: Russ Larson

Targetting (Approved)

PCR 695 Provide Option for CSI Program to Compute T (APOAPSIS)

Action: Bill Robinson, please determine how we should compute T (APOAPSIS) in the LGC.

PCR 268.2 Reduction of P34/P35 Run Time.

Action: Wayne Templeman, please verify the accuracy claims made by MPAD on this subject. Bob Regelbrugge said that conic computations cause an error of only about 0.001 ft/second. I have asked Blake Ireland to try this out by patching P34 in SUNDANCE to see how much time is saved.

Action Item: Dan Lickly, would you please hold a design review to discuss the implementation of this?

Powered Flight (Approved)

PCR 709 Improve TGO Prediction for Short Burns in the Burn Time Routine.

PCR 647 Replace Lambert with "ASTEER" in P40, P41 and P42.

PCR 648 Modify P42 to Permit Staging between TIG-30 and TIG.

Programming action for all the foregoing powered flight items: Peter Adler.

GSOP action: Ray Morth or Pete Philliou, Walker Kupfer (4).

Design reviews have either been held or none are necessary.

Powered Flight (Disapproved)

PCR 650 Variable Guidance Period

This held out the advantage of improving the crew trims because of the higher frequency display of VGs. Is there any easier way of doing this much, a la P66? Action: Peter Adler.

Miscellaneous (Approved)

PCR 719 Speed up P21.

PCR 720 Abort Coasting Integration when in Infinite Acceleration Overflow Loop.

PCR 721 Time-Theta and Time-Radius Alarm Abort.

PCR 659.2 Suppression of Kepler X-Moduling.

PCR 654 Reduce Delays in R31.

Program Action: Jim Kernan or Craig Schulenberg.

GSOP Action: Bill Robinson and Bill Marscher (5), Walker Kupfer (4).

Miscellaneous (Disapproved)

Alternate Angular Reference inputs to the crew defined maneuver routine, R62 (2 days).

Test Plans for Changes

Anyone who has the programming and coding change action must prepare a test plan to prove that his changes are working properly. These will be collated, added to, and made into a LUMINARY 1A Test Plan through Level 3. In same cases, Levels 1 and 2 of testing will be necessary - for example, in the T (APOAPSIS) change.

DISTRIBUTION

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